Physics 131
General Physics I
Grinnell College
Spring 2012

Summary—Unit 7
Oscillations

There are many types of motion that are oscillatory. Those arising from a Hooke's Law force $F = -kx$ are special, in that they give an oscillation

$$x(t) = A\cos(\omega t + \phi)$$

where the oscillation frequency ω is not dependent on the amplitude of oscillation A. The angular frequency ω (often called the natural frequency) is related to the spring constant and the mass by

$$\omega^2 = k/m.$$

We also have a variety of different ways of describing the oscillation frequency, that is the frequency f (in cycles per second) and the period T (in seconds per cycle) in addition to ω (in radians per second), and they are related as follows:

$$f = 1/T = \omega/2\pi.$$

We found that if we introduced a second force or varied the functional form of the restoring (spring) force, we saw variations in the oscillations. In particular, if we added a drag force, we found that the amplitude of the oscillation decreased exponentially with time, as described by an equation like

$$x(t) = A\, e^{-\alpha t}\sin(\omega t)$$

If we made the restoring force non-linear, we found that the period of oscillation would depend on amplitude of the oscillation, and the shape of the oscillation would begin to vary slightly from a pure sinusoidal shape.

Finally we found that if we drive an oscillating system, it will finally oscillate at the same frequency as the driver, but the amplitude of the oscillation is large only if our driving frequency is at a frequency close to the natural frequency. This phenomenon is called resonance.